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SmartRF® 02 - Product line

User Manual

Rev. 2.01

SmartRF® CC1010DK Development Kit



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Introduction

The CC1010 single chip RF transceiver and microcontroller provides a single-chip solution for a wide range of applications. The CC1010DK development kit is designed to make it easy for the user to evaluate the RF performance of the CC1010 and develop application software very quickly.

The Development Kit includes an Evaluation Board and two Evaluation Modules. The Evaluation Modules contain the CC1010 chip and associated support circuits. The Modules can operate in a stand-alone fashion.

The Evaluation Board serves as a motherboard for the Evaluation Modules. The Evaluation Board provides two serial ports, a parallel interface, buttons, LEDs, voltage regulator, configuration jumpers and connectors to make it easy to interface the CC1010 with the IDE, SmartRF® Studio and various test equipment.

This User Manual describes how to use the hardware part of the Development Kit. The Chipcon-supplied software is documented in the IDE user manual, and the Keil µVision 2 C compiler is documented in the Keil documentation. SmartRF® Studio is documented in its own user manual.

The CC1010DK Development Kit includes what you need to evaluate the RF performance of the CC1010, develop your own software for the CC1010 and can also be used to build a prototype of your application. An evaluation version of the Keil µVision 2 C compiler is included on the CD; this has a 2KB code size limitation.

Your SmartRF® CC1010DK Development Kit should contain the following items:

Kit contents	
Item	*Number of articles*
Evaluation Board (CC1010EB)	1
Evaluation Module (CC1010EM)	2
Quick Start instructions	1
Chipcon CD	1
Antenna, 50Ω quarter-wave monopole, SMA male connector	2
SMA to BNC adapters	3
Parallel port cable	1
Serial null-modem cable	1
CC1010 sample kit	1

Evaluation Module

The Evaluation Module contains the CC1010 chip, the needed external circuitry for operation, pull-up resistors for all general I/O pins, test points and a temperature sensor. Not all components are needed in an actual application. Please see the datasheet for a typical application circuit.

The Evaluation Module is produced in two versions; the difference between them is the frequency band of operation. One version is optimized for use at 433 MHz, the other for use at 868 MHz and at 915 MHz. This covers the most used frequency bands, the 433 MHz band in Europe and the US, the 868 MHz band in Europe, and the 902-928 MHz band in the US. See application note AN001 for more information about applicable regulations. The operating frequency band is marked on the PCB.

Circuit description

The CC1010 RF section includes all the necessary components for correct operation. An LC filter is inserted between the CC1010 RF input/output and the antenna connector to reduce harmonics. This LC filter is of the 3dB-equal ripple (Chebychev) low-pass type. The design equations are:

$$\omega_C \approx \omega_{RF} \cdot \left(\frac{1}{1-0.1333} \right), \qquad L = \frac{35.6}{\omega_C}, \qquad C = \frac{0.067}{\omega_C},$$

where ω_C is the cut-off frequency and ω_{RF} is the transmitted RF frequency. The filter is designed for 50Ω termination impedances. If you wish to evaluate the CC1010 without an LC filter, please remove capacitors C8 and C) and replace the L1 inductor with a 0Ω resistor.

The VCO inductor (L101) is located on the bottom side of the PCB, all other RF components are on the top side.

The CC1010 is connected to both a 14.7456 MHz high-frequency crystal and a 32.768 kHz low-frequency crystal. The high-frequency crystal is furnished with a trimmer capacitor to adjust the initial frequency tolerance. An external signal can be applied at test pin TP1, remember to remove the crystal before applying an external clock signal. The external clock should have an amplitude of 1 – 3 V peak-to-peak.

Power can easily be applied to the board by using the TP3 and TP4 test points, or connecting the power source to the adjoining bare copper areas. The TP2, TP5 and TP6 test points provide easy access to the P0.0, P0.1 and P0.2 I/O pins, respectively.

All general-purpose I/O pins are furnished with pull-up resistors, ensuring that the pins do not float if they are configured as inputs. An LM-61 temperature sensor from National Semiconductor is also included on the board, and is connected to the AD1 pin. If this pin is to be used for other purposes, the temperature sensor should be removed.

The Evaluation Module can be plugged into the Evaluation Board. 2 2x20 pin pin-row connectors with 0.050-inch pitch are used for this purpose. Shorting the T1 and T2 pads together for a short period will reset the CC1010.

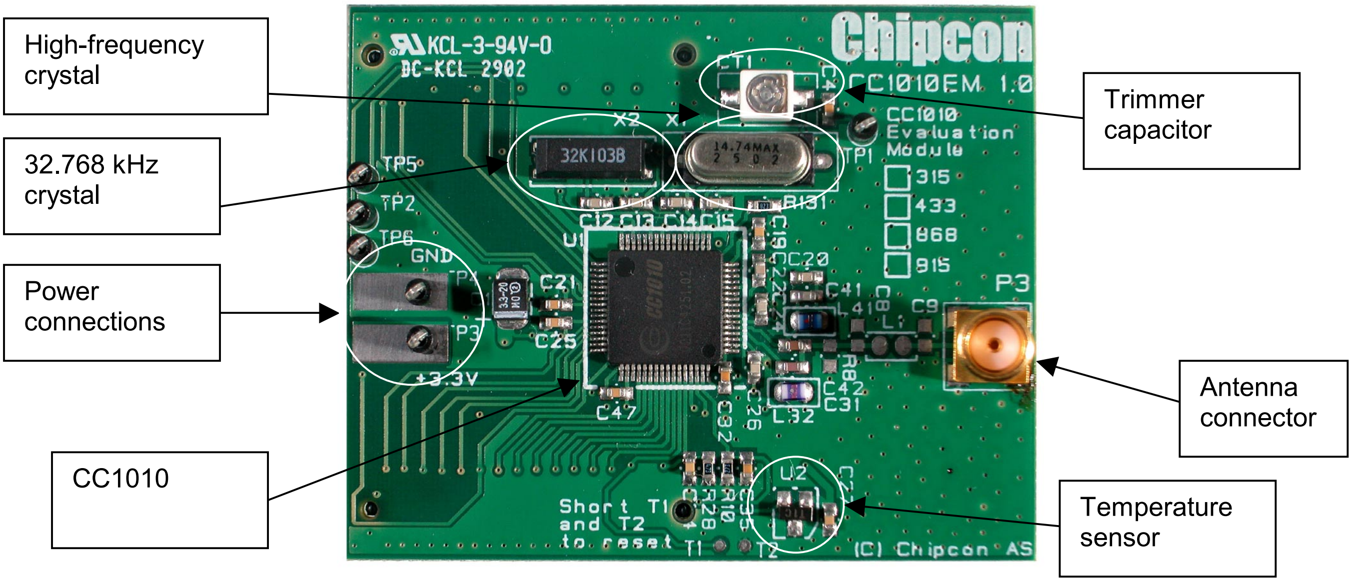


Figure 1: CC1010EM Evaluation Module

PCB layout

The figure above shows the 1.0 revision of the PCB. Later revisions are similar, but have the following additional features:

- 0-ohm series resistor between the temperature sensor and the AD1 bit of CC1010. Instead of desoldering the temperature sensor if you wish to use AD1 for other purposes, you can desolder the 0-ohm resistor.
- 0-ohm series resistor between temperature sensor and VDD. Instead of desoldering the temperature sensor when measuring the power-down current of the CC1010, you can desolder the 0-ohm resistor.

RF circuits operating at high frequencies are sensitive to the physical layout of the PCB. Chipcon has carefully optimized the layout of the CC1010EM evaluation module, and we recommend that you copy it when making your own PCB design.

The PCB is of a 4-layer type in order to provide a good ground plane as well as adequate routing space. The laminate used is standard FR-4 board material. The PCB is 1.6mm thick, with layer 1 on the top side, layers 2 and 3 are internal layers and layer 4 is on the bottom side. Layers 1 and 4 are used for routing, while layer 2 is a ground plane and layer 3 is used for power routing. All areas not utilized for routing are filled with copper connected to ground to provide RF shielding. The ground planes on all layers are stitched together with closely spaced vias.

To minimize LO leakage and allow space for decoupling capacitors close to the CC1010, the VCO inductor (L101) is placed on the bottom side of the PCB. EMI beads for power-supply filtering are also placed on the bottom side, together with the pull-up resistors. All other components are placed on the top side of the PCB.

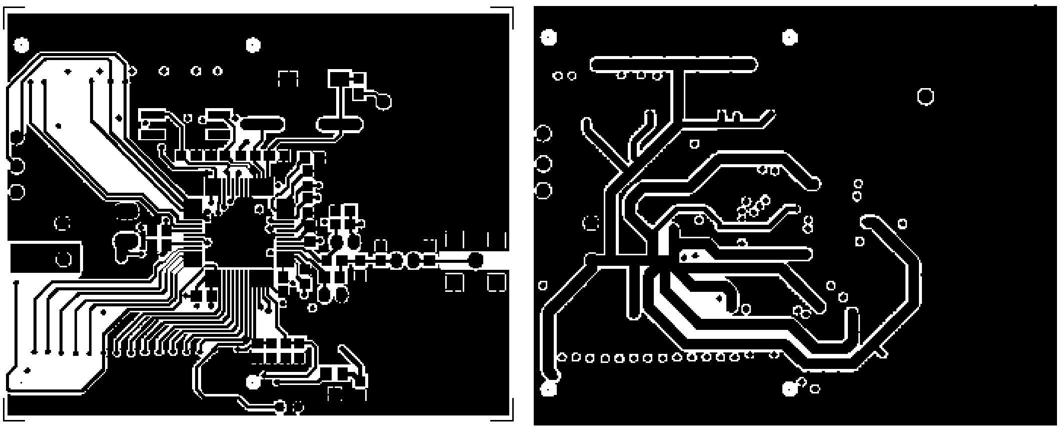


Figure 2: CC1010EM PCB layout, layer 1 (left) and layer 3 (right)

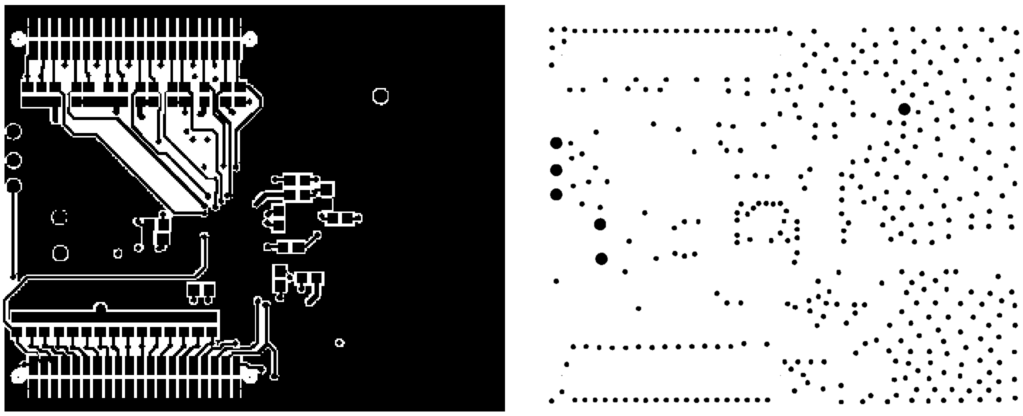


Figure 3: CC1010EM PCB layout, layer 4 (left) and layer 2 (right, negative)

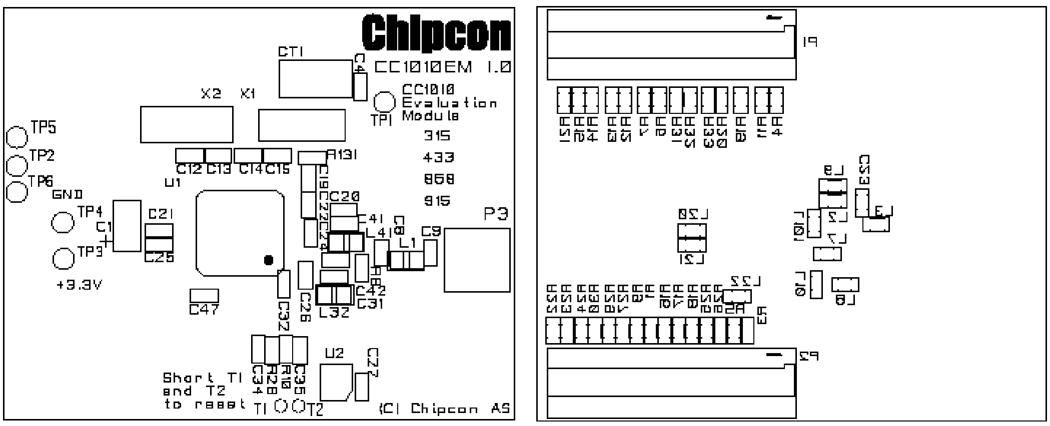
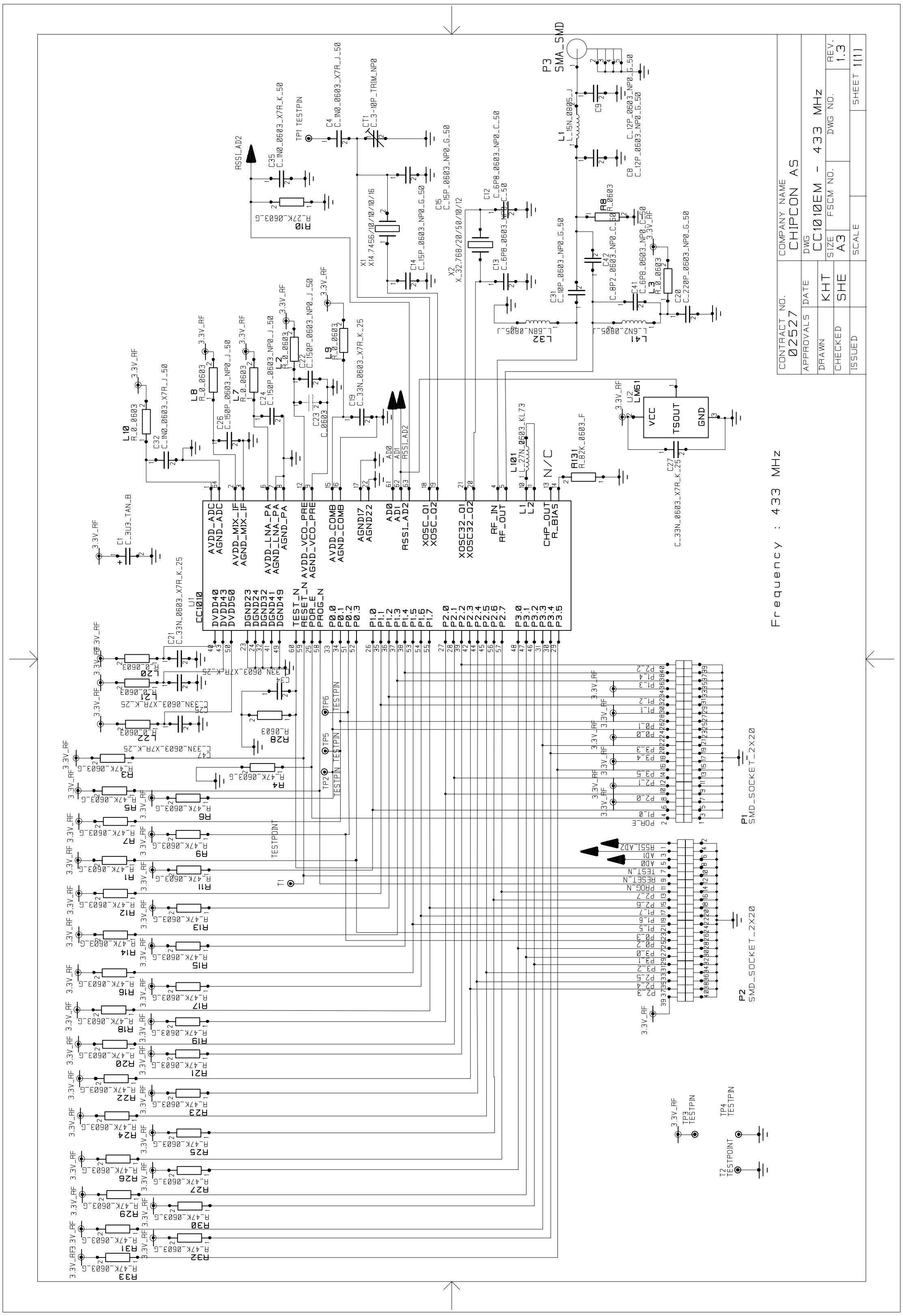


Figure 4: CC1010EM component placement, top side (left) and bottom side (right)

Schematic, CC1010EM-433



Please note that the TEST_N pin should be connected to VDD in your design. See page 40 for more information.

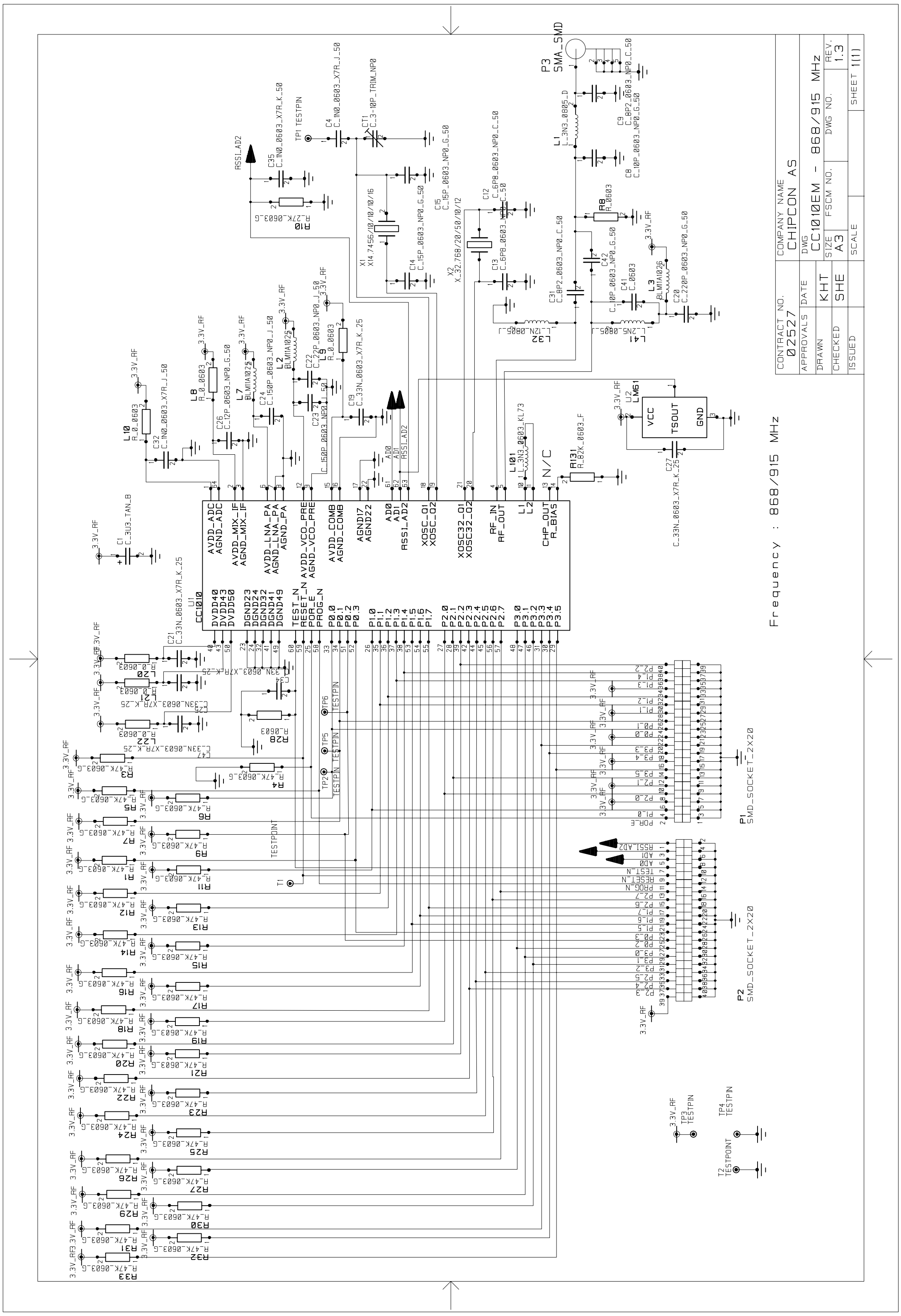
Bill of materials, CC1010EM-433

Bill of materials, CC1010EM-433			
Reference	*Description*	*Value*	*Part*
C1	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C4	Capacitor 0603	1nF, 5%	C_1N0_0603_X7R_J_50
C8	Capacitor 0603	12pF, 5%	C_12P_0603_NP0_J_50
C9	Capacitor 0603	12pF, 5%	C_12P_0603_NP0_J_50
C12	Capacitor 0603	6.8pF, ±0.25pF	C_6P8_0603_NP0_C_50
C13	Capacitor 0603	6.8pF, ±0.25pF	C_6P8_0603_NP0_C_50
C14	Capacitor 0603	15pF, 5%	C_15P_0603_NP0_K_50
C15	Capacitor 0603	15pF, 5%	C_15P_0603_NP0_K_50
C19	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C20	Capacitor 0603	220pF, 5%	C_220P_0603_NP0_G_50
C21	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C22	Capacitor 0603	150pF, 5%	C_150P_0603_NP0_G_50
C23	Capacitor 0603 general		Do not mount
C24	Capacitor 0603	150pF, 5%	C_150P_0603_NP0_J_50
C25	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C26	Capacitor 0603	150pF, 5%	C_150P_0603_NP0_J_50
C27	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C31	Capacitor 0603	10pF, 5%	C_10P_0603_NP0_J_50
C32	Capacitor 0603	1nF, 5%	C_1N0_0603_X7R_J_50
C34	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C35	Capacitor 0603	1nF, 10%	C_1N0_0603_X7R_K_50
C41	Capacitor 0603	6.8pF, ±0.25pF	C_6P8_0603_NP0_C_50
C42	Capacitor 0603	8.2pF, ±0.25pF	C_8P2_0603_NP0_C_50
C47	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
CT1	Trimmer Capacitor	3-10pF	C_3-10P_TRIM_NP0
L1	Inductor 0805	15nH, 5%	L_15N_0805_J
L2	Resistor 0603	0Ω	R_0_0603
L3	Resistor 0603	0Ω	R_0_0603
L7	Resistor 0603	0Ω	R_0_0603
L8	Resistor 0603	0Ω	R_0_0603
L9	Resistor 0603	0Ω	R_0_0603
L10	Resistor 0603	0Ω	R_0_0603

Bill of materials, CC1010EM-433			
Reference	*Description*	*Value*	*Part*
L20	Resistor 0603	0Ω	R_0_0603
L21	Resistor 0603	0Ω	R_0_0603
L22	Resistor 0603	0Ω	R_0_0603
L32	Inductor 0805	68nH, 5%	L_68N_0805_J
L41	Inductor, 0805	6.2nH, 5%	L_6N2_0805_J
L101	Inductor, 0603 (KOA)	27nH, 5%	L_27N_0603_KL73, KOA KL731JTE27NJ
P1	SMD pin-row socket, .050 spacing		SMD_SOCKET_2X20, Samtec SFM-120-02-S-D-A-K-TR
P2	SMD pin-row socket, .050 spacing		SMD_SOCKET_2X20, Samtec SFM-120-02-S-D-A-K-TR
P3	Surface-mount SMA, straight		SMA_SMD
R1	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R3	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R4	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R5	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R6	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R7	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R8	Resistor 0603, general		Do Not Mount
R9	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R10	Resistor 0603	27kΩ, 2%	R_27K_0603_G
R11	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R12	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R13	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R14	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R15	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R16	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R17	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R18	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R19	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R20	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R21	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R22	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R23	Resistor 0603	47kΩ, 2%	R_47K_0603_G

Bill of materials, CC1010EM-433			
Reference	*Description*	*Value*	*Part*
R24	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R25	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R26	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R27	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R28	Resistor 0603		Do not mount
R29	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R30	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R31	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R32	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R33	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R131	Resistor 0603	82kΩ, 1%	R_82K_0603_F
TP1	Testpoint		TESTPIN
TP2	Testpoint		TESTPIN
TP3	Testpoint		TESTPIN
TP4	Testpoint		TESTPIN
TP5	Testpoint		TESTPIN
TP6	Testpoint		TESTPIN
U1	Single-chip transceiver and microcontroller		CC1010
U2	Temperature sensor, SOT23		LM61, National Semiconductor LM61CIM3
X1	Crystal, HC-49-SMD		X 14.7456 MHz 10/10/10/16pF load
X2	Watch crystal, plastic SMD package		X 32.768 kHz 20/50/10/12pF load

Schematic, CC1010EM-868



Please note that the TEST_N pin should be connected to VDD in your design. See page 40 for more information.

Bill of materials, CC1010EM-868

Bill of materials, CC1010EM-868			
Reference	*Description*	*Value*	*Part*
C1	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C4	Capacitor 0603	1nF, 5%	C_1N0_0603_X7R_J_50
C8	Capacitor 0603	10pF, 5%	C_10P_0603_NP0_J_50
C9	Capacitor 0603	8.2pF, ±0.25pF	C_8P2_0603_NP0_C_50
C12	Capacitor 0603	6.8pF, ±0.25pF	C_6P8_0603_NP0_C_50
C13	Capacitor 0603	6.8pF, ±0.25pF	C_6P8_0603_NP0_C_50
C14	Capacitor 0603	15pF, 5%	C_15P_0603_NP0_J_50
C15	Capacitor 0603	15pF, 5%	C_15P_0603_NP0_J_50
C19	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C20	Capacitor 0603	220pF, 5%	C_220P_0603_NP0_G_50
C21	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C22	Capacitor 0603	22pF, 5%	C_22P_0603_NP0_J_50
C23	Capacitor 0603	150pF, 5%	C_150P_0603_NP0_J_50
C24	Capacitor 0603	150pF, 5%	C_150P_0603_NP0_J_50
C25	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C26	Capacitor 0603	12pF, 5%	C_12P_0603_NP0_J_50
C27	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C31	Capacitor 0603	8.2pF, ±0.25pF	C_8P2_0603_NP0_C_50
C32	Capacitor 0603	1nF, 5%	C_1N0_0603_X7R_J_50
C34	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C35	Capacitor 0603	1nF, 10%	C_1N0_0603_X7R_K_50
C41	Capacitor 0603, general		Do Not Mount
C42	Capacitor 0603	10pF, 5%	C_10P_0603_NP0_J_50
C47	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
CT1	Trimmer Capacitor	3-10pF	C_3-10P_TRIM_NP0
L1	Inductor 0805	3.3nH, ± 0.5nH	L_3N3_0805_D
L2	EMI Filter Bead		BLM18HG102SN1D, Murata
L3	EMI Filter Bead		BLM18HG102SN1D, Murata
L7	EMI Filter Bead		BLM18HG102SN1D, Murata
L8	Resistor 0603	0Ω	R_0_0603
L9	Resistor 0603	0Ω	R_0_0603
L10	Resistor 0603	0Ω	R_0_0603
L20	Resistor 0603	0Ω	R_0_0603

Bill of materials, CC1010EM-868			
Reference	*Description*	*Value*	*Part*
L21	Resistor 0603	0Ω	R_0_0603
L22	Resistor 0603	0Ω	R_0_0603
L32	Inductor 0805	12nH, 5%	L_12N_0805_J
L41	Inductor, 0805	2.5nH, 5%	L_2N5_0805_J
L101	Inductor, 0603 (KOA)	3.3nH, 5%	L_3N3_0603_KL73, KOA KL731JTE3N3J
P1	SMD pin-row socket, .050 spacing		SMD_SOCKET_2X20, Samtec SFM-120-02-S-D-A-K-TR
P2	SMD pin-row socket, .050 spacing		SMD_SOCKET_2X20, Samtec SFM-120-02-S-D-A-K-TR
P3	Surface-mount SMA, straight		SMA_SMD
R1	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R3	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R4	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R5	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R6	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R7	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R8	Resistor 0603,general		Do Not Mount
R9	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R10	Resistor 0603	27kΩ, 2%	R_27K_0603_G
R11	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R12	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R13	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R14	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R15	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R16	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R17	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R18	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R19	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R20	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R21	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R22	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R23	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R24	Resistor 0603	47kΩ, 2%	R_47K_0603_G

Bill of materials, CC1010EM-868			
Reference	*Description*	*Value*	*Part*
R25	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R26	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R27	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R28	Resistor 0603		Do not mount
R29	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R30	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R31	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R32	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R33	Resistor 0603	47kΩ, 2%	R_47K_0603_G
R131	Resistor 0603	82kΩ, 1%	R_82K_0603_F
TP1	Testpoint		TESTPIN
TP2	Testpoint		TESTPIN
TP3	Testpoint		TESTPIN
TP4	Testpoint		TESTPIN
TP5	Testpoint		TESTPIN
TP6	Testpoint		TESTPIN
U1	Single-chip transceiver and microcontroller		CC1010
U2	Temperature sensor, SOT23		LM61, National Semiconductor LM61CIM3
X1	Crystal, HC-49-SMD		X 14.7456 MHz 10/10/10/16pF load
X2	Watch crystal, plastic SMD package		X 32.768 kHz 20/50/10/12pF load

Evaluation Board

The Evaluation Board is used as a motherboard for the Evaluation Modules, providing external circuitry for easy prototyping and connectors for easy connection to external equipment. The figure below shows the first revision of the Evaluation Board; in revisions 3.0 and later the AD1 and AD2 connectors were removed, and a separate connector for analog data out was added.

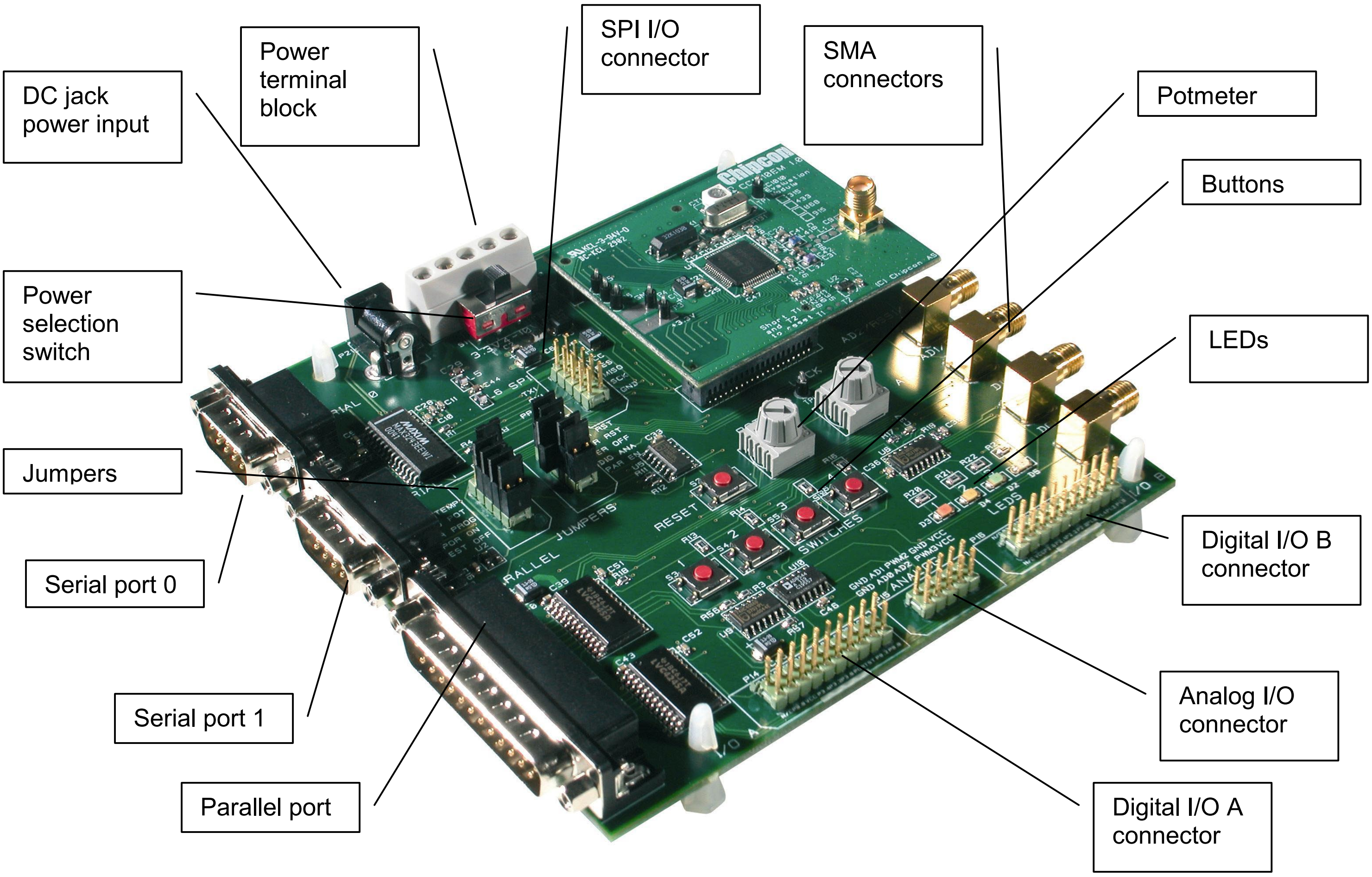


Figure 5: CC1010EB Evaluation Board (with CC1010EM plugged in)

Power supply section

You can choose between applying a 4-10V unregulated supply voltage or a 3.3V regulated supply voltage by using the SPDT switch. If an unregulated supply voltage is applied, a on-board regulator supplies 3.3V to the board. A diode prevents damage if wrong polarity is applied to the non-regulated input. There are two power connectors; a 3.5mm DC jack-type connector allows you to connect an unregulated battery eliminator easily (the positive supply is on the center pin), and a 5-pin terminal block for connecting either an unregulated or regulated power supply.

An amperemeter can also be connected in order to measure the DC current drawn by the CC1010. Note that these terminals measure all the current going to the CC1010 Evaluation Module, therefore current drawn by the temperature sensor and pull-up resistors will also be measured. If you are going to measure the power-down current of the CC1010 accurately, you should remove the temperature sensor on the Evaluation Module (it draws over 100uA), and set all the CC1010 I/O pins to be inputs or outputs set to the high state. If you are not going to measure the current, a short-circuit jumper must be connected between these two terminals, otherwise the Evaluation Module will not be supplied with power.

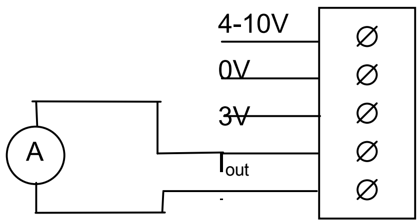


Figure 6: Power terminal block with amperemeter attached

On the PCB, all pins connected to regulated power are marked with VCC. On the schematics, this net is called +3.3V. Power going to the Evaluation Module connector is named +3.3V_RF.

RS-232 interfaces

The Evaluation Board provides two serial ports, Serial 0 and Serial 1. The serial ports are configured as DTE (Data Terminal Equipment, in other words identical to a PC). Therefore, a null-modem cable with data lines crossed must be used to connect these ports to a PC. A level-conversion circuit is provided to convert the CMOS levels used by the CC1010 into RS-232 compliant bipolar +5V/-5V signals. Note that this circuit contains a charge-pump power supply that is quite noisy. When doing performance evaluation of the CC1010 RF section, we recommend that you turn this circuit off by inserting the SER OFF strap.

Serial 0 implements the RTS/CTS handshaking pair, so that hardware handshaking may be used on this port. These signals are available at pins P1.5 and P1.6. Serial 1 is primarily used by the Keil debugger to communicate with the CC1010 when the debugger is running. Serial 1 does not implement hardware handshaking. A way to reset the CC1010 via this port is provided; removing the SER RST jumper will disable this function.

Parallel interface

The Evaluation Board also provides a parallel interface for connection to a parallel port on a PC. This interface is used to communicate with SmartRF® Studio and the CC1010 Flash Programmer program. The parallel interface can be disconnected from the CC1010 I/O pins by removing the PAR EN jumper. Removing the PAR PROG jumper will disable parallel programming of the CC1010.

Jumpers

The jumpers are used to configure the Evaluation Board. The factory default settings are shown below, please return to these settings if you are experiencing any problems.

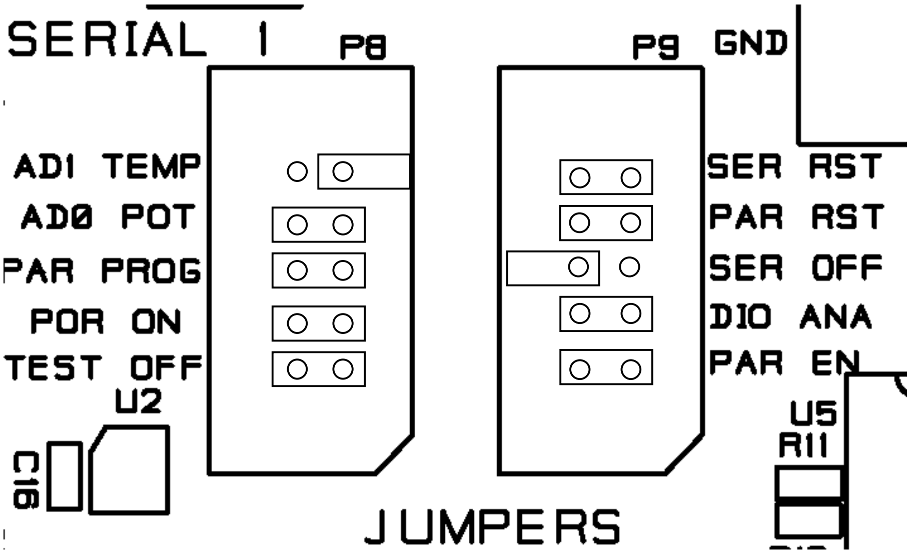


Figure 7 Default jumper settings

Jumpers		
Name	*Default setting*	*Description*
AD1 TEMP	Not present	If present, connects the temperature sensor footprint on the Evaluation Board to the AD1 pin of the CC1010. (Note: This jumper does not control the temperature sensor located on the Evaluation Module) In PCB revision 3.0 and later, this strap does not exist. Neither does the footprint on the EB for the temperature sensor.
AD0 POT	Present	If present, connects the RT1 potmeter to the AD0 pin of the CC1010.
PAR PROG	Present	If present, enables programming of the CC1010 Flash memory via the parallel interface.
POR ON	Present	If present, enables the internal power-on reset module of the CC1010. When enabled, the supply voltage must be over 2.9V ±0.2V for the CC1010 to exit the reset condition.
TEST OFF	Present	This jumper should always be present.
SER RST	Present	If present, enables resetting the CC1010 via the SERIAL 1 serial port.
PAR RST	Present	If present, enables resetting the CC1010 via the parallel interface.
SER OFF	Not present	If present, disables the RS-232 interface circuitry. Because this circuitry generates noise, we recommend disabling it when sensitive RF measurements are performed. If the circuitry is disabled, the serial ports cannot be used.
DIO ANA	Present	When present, enables adjustment of the DIO peak-to-peak signal level using the DIO ATT potmeter when performing BER testing using SmartRF® Studio. In PCB revision 3.0 and later, this strap does not exist as analog data out has its own separate connector.
PAR EN	Present	When present, enables the parallel interface. If this is disabled, communication with SmartRF® Studio or the CC1010 Flash programmer is impossible.

Peripherals

The Evaluation Board includes a number of peripherals to allow quick testing and prototyping.

A potmeter (RT1, marked “POT”) provides an analogue voltage that can be applied to the AD0 pin of the CC1010.

Four momentary pushbuttons are provided. They are connected to pins P1.7, P3.2, P3.3 and P2.4. The buttons connect the I/O pins to ground when pushed.

Four LEDs are provided. They are connected to pins P1.2, P1.3, P1.4 and P2.5. LED 1 is red, LED 2 is yellow, LED 3 is green and LED 4 is blue. The LEDs are connected to VCC via resistors, and the cathodes are connected to the CC1010 I/O pins via a buffer. Driving the CC1010 pin low will therefore light the LED.

The two PWM outputs of the CC1010 (PWM2 at pin P3.4 and PWM3 at pin P3.5) are provided with buffers and RC-filters with a 3-kHz cutoff frequency. The outputs from the filters are buffered by rail-to-rail op-amps, and are available at the ANALOG pin-row connector (P15).

A footprint for a LM61 temperature sensor from National Semiconductor is provided on the PCB. This component is not mounted at the factory; rather there is an identical sensor on the Evaluation Module.

A reset button is provided. When pushed, it will reset the CC1010 by pulling its RESET line low.

Peripheral summary		
Peripheral	*CC1010 pin*	*Description*
POT (RT1)	AD0	10kΩ Potmeter. Can apply a voltage between VCC and 0V. Can be disconnected from AD0 by removing the AD0 POT jumper.
Button 1	P1.7	Momentary pushbutton. When activated, pulls I/O line low.
Button 2	P3.2	Momentary pushbutton. When activated, pulls I/O line low.
Button 3	P3.3	Momentary pushbutton. When activated, pulls I/O line low.
Button 4	P2.4	Momentary pushbutton. When activated, pulls I/O line low.
LED 1	P1.2	Red LED. Buffered, lights up when I/O line is pulled low.
LED 2	P1.3	Yellow LED. Buffered, lights up when I/O line is pulled low.
LED 3	P1.4	Green LED. Buffered, lights up when I/O line is pulled low.
LED 4	P2.5	Blue LED. Buffered, lights up when I/O line is pulled low.
PWM 2 buffer and filter	P3.4	PWM output is buffered by CMOS buffer, then low-pass filtered (RC filter with 3 kHz cut-off frequency) and buffered by a rail-to-rail op-amp. Output available at ANALOG connector.
PWM 3 buffer and filter	P3.5	PWM output is buffered by CMOS buffer, then low-pass filtered (RC filter with 3 kHz cut-off frequency) and buffered by a rail-to-rail op-amp. Output available at ANALOG connector.
Temperature sensor	AD1	Footprint for LM61CIM3 temperature sensor from National Semiconductor. Not mounted. Can be disconnected from AD1 by removing the AD0 POT jumper. This footprint is not present on revision 3.0 or later of the PCB. Note that an identical temperature sensor is mounted on the Evaluation Module.

Connectors

The Evaluation Board is furnished with many connectors for easy access to signals.

The I/O A (P14) and I/O B (P16) 2x10 pin pin-row connectors bring out all the general digital I/O pins of the CC1010. The pin-out is compatible with logic analyzer probes from Agilent.

Analog signals are brought out on the 2x5 pin ANALOG (P15) connector. All A/D inputs to the CC1010 are available here, as well as buffered and filtered PWM outputs.

The SPI (P5) connector brings out all signals related to CC1010 Flash programming and CC1010 SPI Master functionality.

The Evaluation Modules are plugged into sockets P1 and P2. These sockets are keyed, and it is not possible to orient the module incorrectly. Make sure you have turned off all power to the Evaluation Board before inserting or removing any Modules.

Several important signals have been brought out on SMA connectors for easy access. AD2/RSSI/IF brings out the AD2/RSSI/IF pin on the CC1010. The AD1/REF connector is connected to the AD1 pin on the CD1010. The DIO and DCLK pins are connected to the P0.1 and P0.2 pins on the CC1010. When using SmartRF® Studio, the CC1010 can "emulate" the CC1000 for RF measurements. The recovered clock signal will then be available on the DIO connector, and DIO will present received data in RX mode, and the user can apply data to DIO in TX mode. The DIO ATT potmeter can be used to adjust the amplitude of the DIO signal in TX mode when BER measurements are done. Please see the section on BER testing in this manual for more information.

Some modifications have been made on PCB revisions 3.0 and later. The AD1/REF and AD2/RSSI/IF SMA connectors have been removed (the signals are still available on the ANALOG pin-row connector), and a separate analog data out connector has been added.

The identity of each pin is shown in the PCB silkscreen next to each pin. The tables below provide further information.

If you make your own custom CC1010 PCB, we recommend including a connector similar to the SPI connector on the CC1010EB. You can then connect the two connectors together with a flat cable and use the CC1010EB to program flash and run the debugger. If you connect the VCC pins together, make sure that you've thought out the power supply issues. The regulator on the CC1010EB is not dimensioned for delivering large currents. The two boards should run on a common power supply.

SPI Connector (P5)	
Pin	*Description*
1	GND
2	GND
3	SCK
4	MOSI
5	MISO
6	PROG_N
7	RESET_N
8	RXD1 (P2.0)
9	VCC
10	TXD1 (P2.1)

Digital I/O connector A (P14)	
Pin	*Description*
1	No connection
2	No connection
3	P0.0
4	VCC
5	VCC
6	P3.5
7	P3.4
8	P3.3
9	P3.2
10	P3.1
11	P3.0
12	PROG_N
13	POR_E
14	RESET_N
15	TEST_N
16	P0.3
17	P0.2
18	P0.1
19	P0.0
20	GND

Digital I/O connector B (P16)	
Pin	*Description*
1	No connection
2	No connection
3	VCC
4	P2.7
5	P2.6
6	P2.5
7	P2.4
8	P2.3
9	P2.2
10	P2.1
11	P2.0
12	P1.7
13	P1.6
14	P1.5
15	P1.4
16	P1.3
17	P1.2
18	P1.1
19	P1.0
20	GND

Analog I/O connector (P15)	
Pin	*Description*
1	GND
2	GND
3	AD0
4	AD1
5	AD2
6	Buffered output from RC filter for PWM2
7	Buffered output from RC filter for PWM3
8	GND
9	VCC
10	VCC

CC1010 I/O pin summary			
Pin	*Alternate function*	*Connector*	*Connected peripherals*
AD0		ANALOG pin 3	Potmeter (POT, RT1)
AD1		ANALOG pin 4	Temperature sensor.
AD2	RSSI, external IF	ANALOG pin 5, SMA connector	SMA connector not present on PCB revision 3.0 and later
P0.0	SCK (Flash programming and SPI Master)	P14 pin 3 and 19, SPI pin 3	
P0.1	MOSI (Flash programming and SPI Master), DIO	P14 pin 18, SPI pin 4, SMA	DIO analog amplitude circuitry
P0.2	MISO (Flash programming and SPI Master), DCLK	P14 pin 17, SPI pin 5, SMA	
P0.3		P14 pin 16	
P1.0		P16 pin 19	
P1.1		P16 pin 18	
P1.2		P16 pin 17	LED 1 (red)
P1.3		P16 pin 16	LED 2 (yellow)
P1.4		P16 pin 15	LED 3 (green)
P1.5		P16 pin 14	RTS0 (Ready To Send on serial port 0)
P1.6		P16 pin 13	CTS0 (Clear To Send on serial port 0)
P1.7		P16 pin 12	Button 1
P2.0	UART 1 receive data	P16 pin 11	RXD1 (Receive data on serial port 1)
P2.1	UART 1 transmit data	P16 pin 10	TXD1 (Transmit data on serial port 1)
P2.2		P16 pin 9	DIO_SELECT (Toggles between analog and digital DIO operation) This signal is not used in PCB revisions 3.0 and later.
P2.3		P16 pin 8	
P2.4		P16 pin 7	Button 4
P2.5		P16 pin 6	LED 4 (blue)
P2.6	LOCK	P16 pin 5, TP6	
P2.7		P16 pin 4	
P3.0	UART 0 receive data	P14 pin 11	RXD0 (Receive data on serial port 0)
P3.1	UART 1 transmit data	P14 pin 10	TXD0 (Transmit data on serial port 0)
P3.2	INT0 external interrupt	P14 pin 9	Button 2

CC1010 I/O pin summary			
Pin	*Alternate function*	*Connector*	*Connected peripherals*
P3.3	INT1 external interrupt		
P3.4	PWM2, T0 external input		
P3.5	PWM3, T1 external input		

PCB layout

The Evaluation Board is a 4-layer, 1.6mm thick FR-4 PCB. Four layers are used because of the routing requirements. Layers 1 and 4 are used for signal routing, layer 2 is a ground plane and layer 3 is a power plane.

All components are mounted on the top side of the PCB.

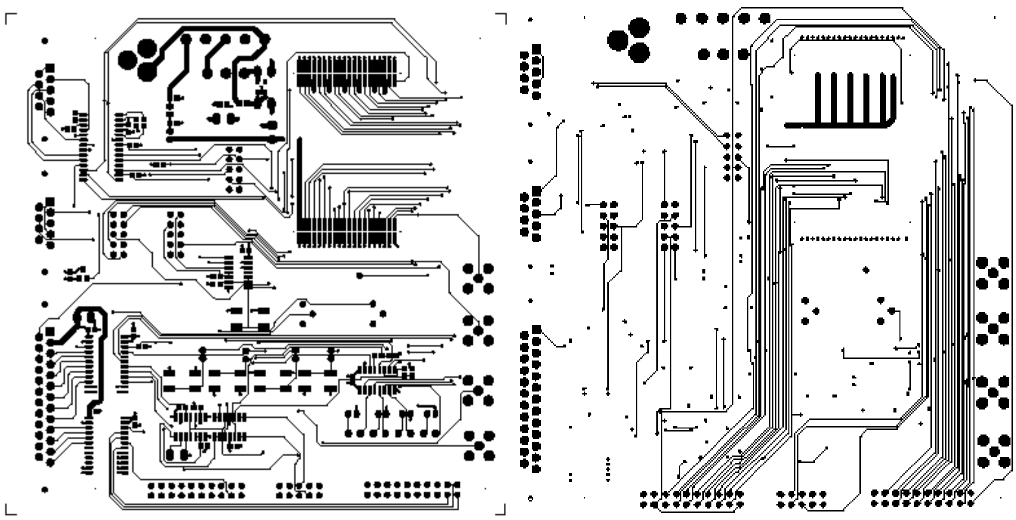


Figure 8: CC1010EB PCB layout, layer 1 (left) and layer 4 (right)

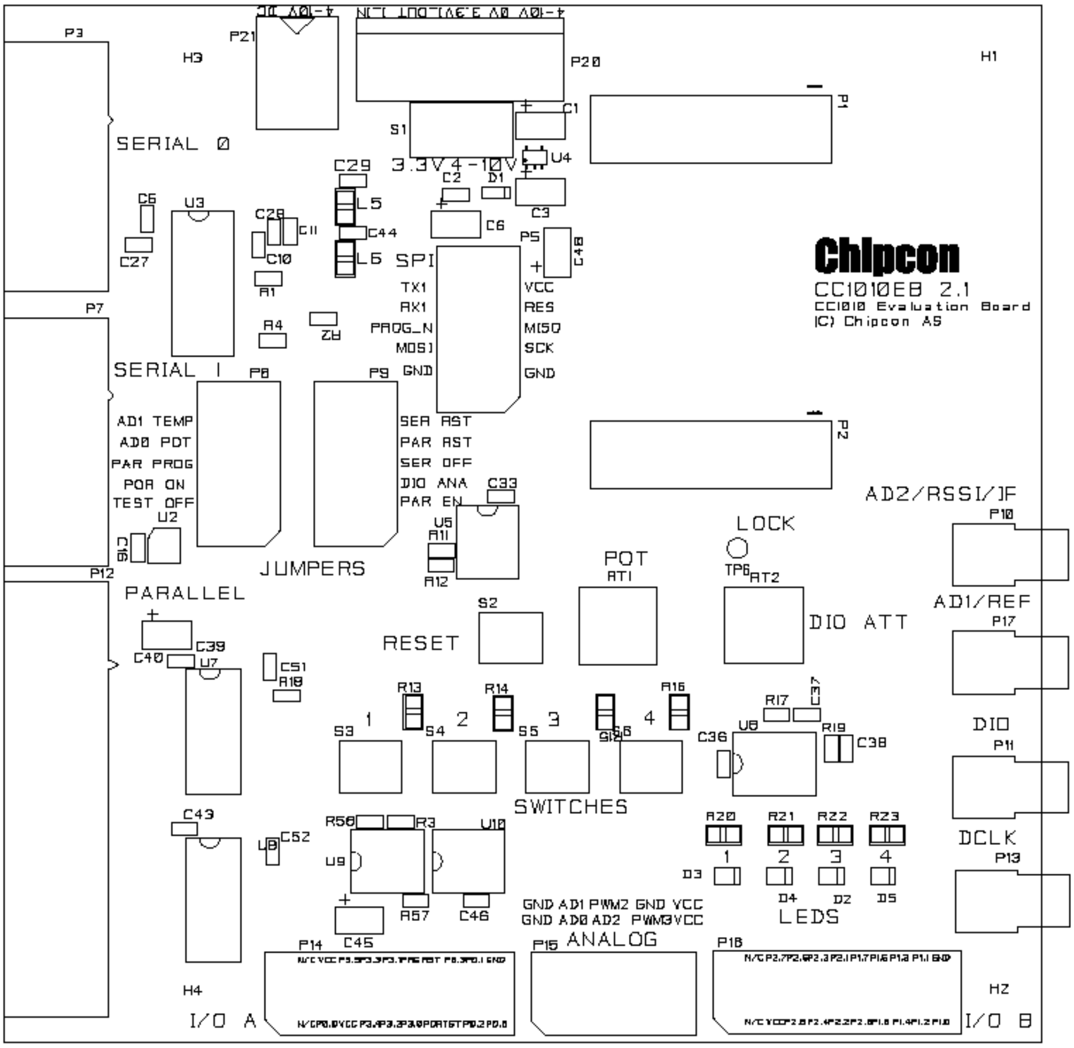
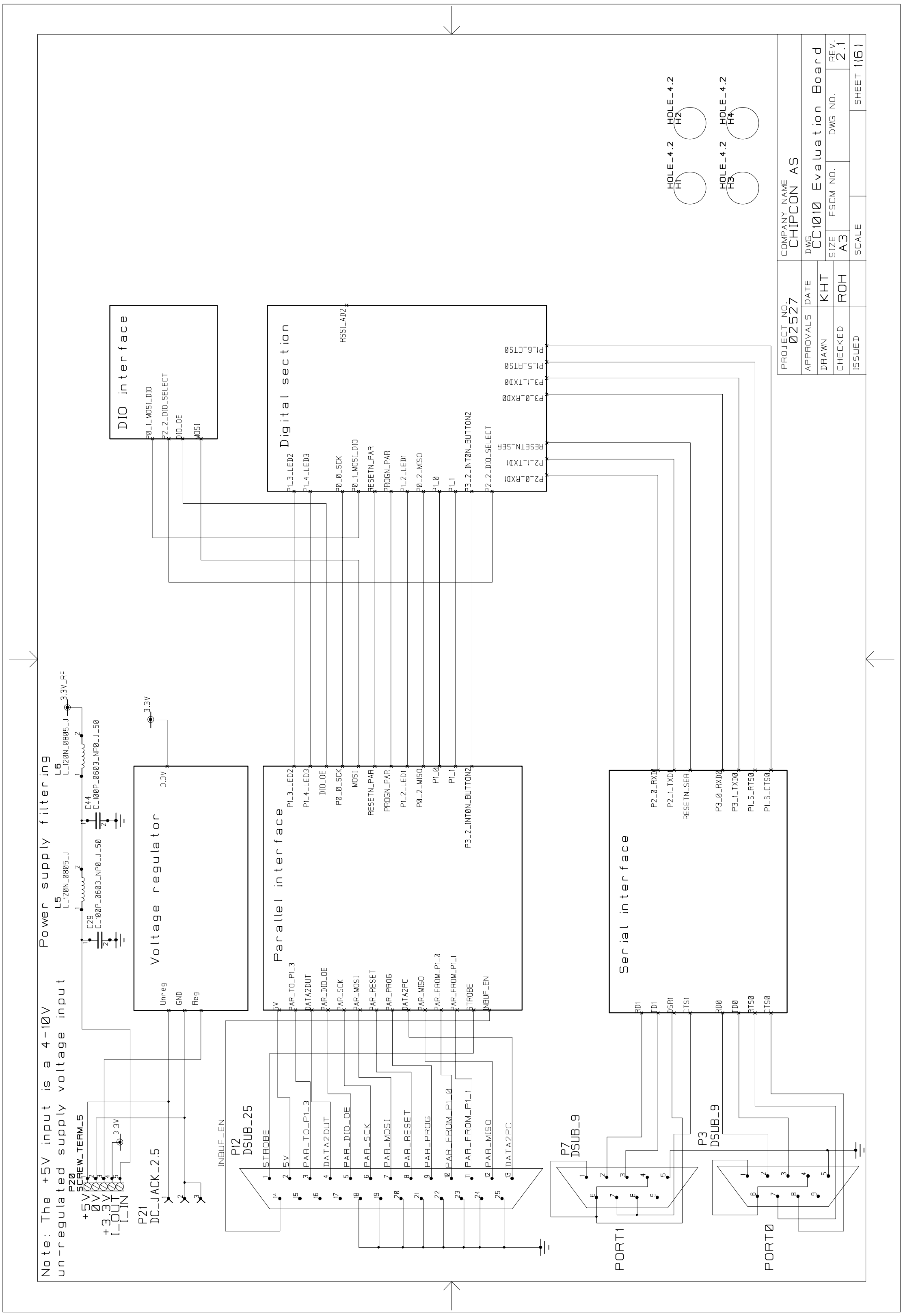
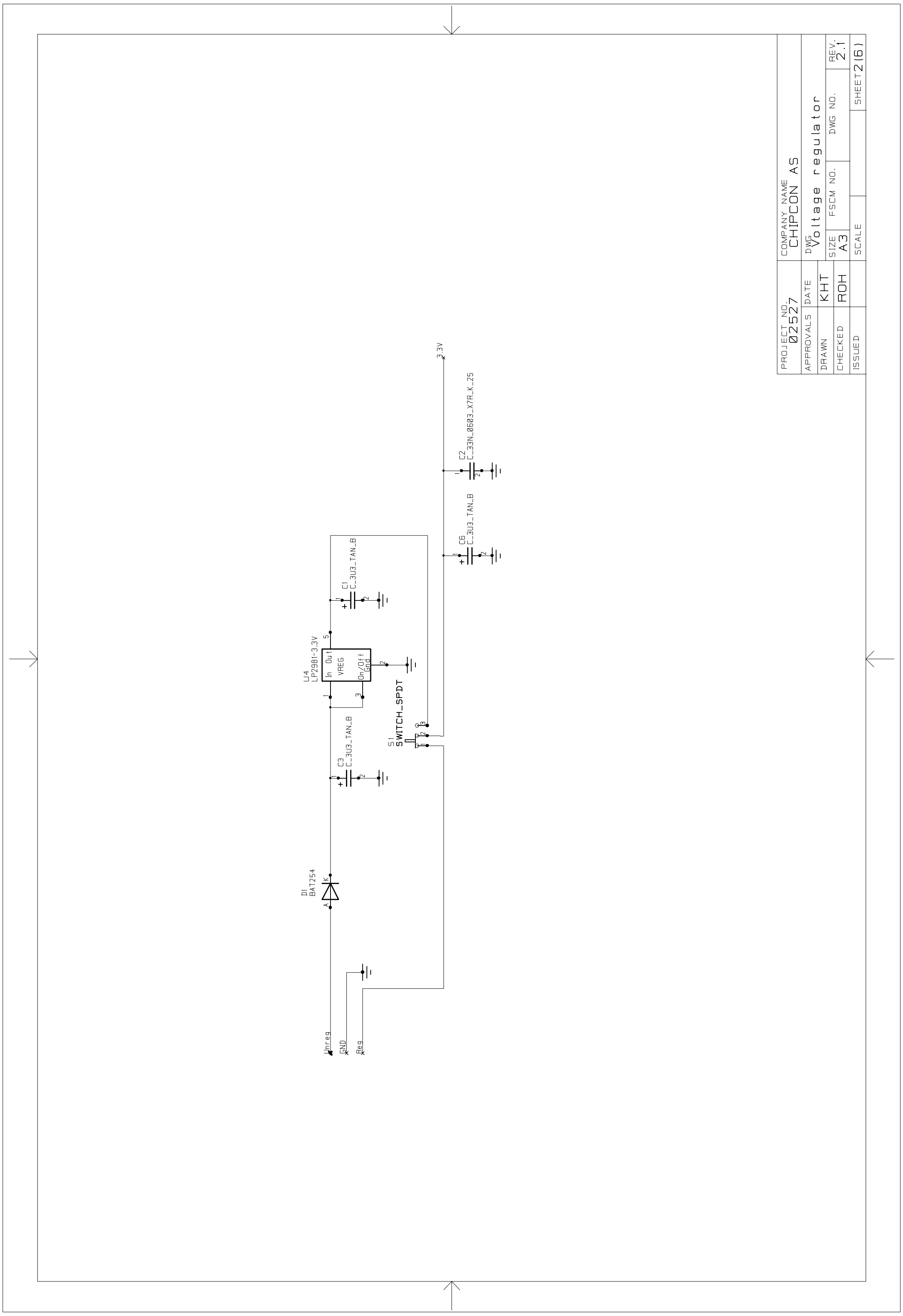
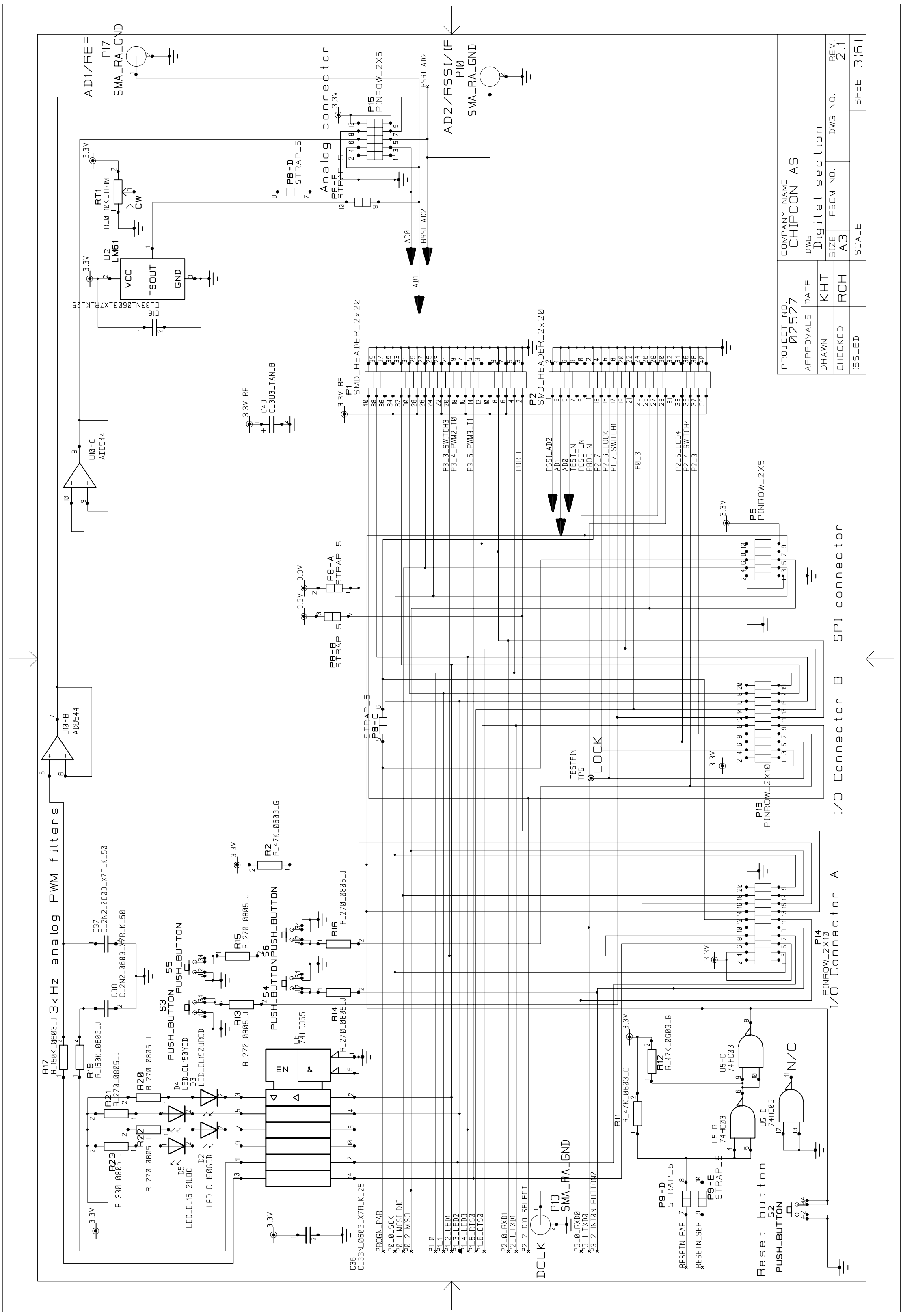


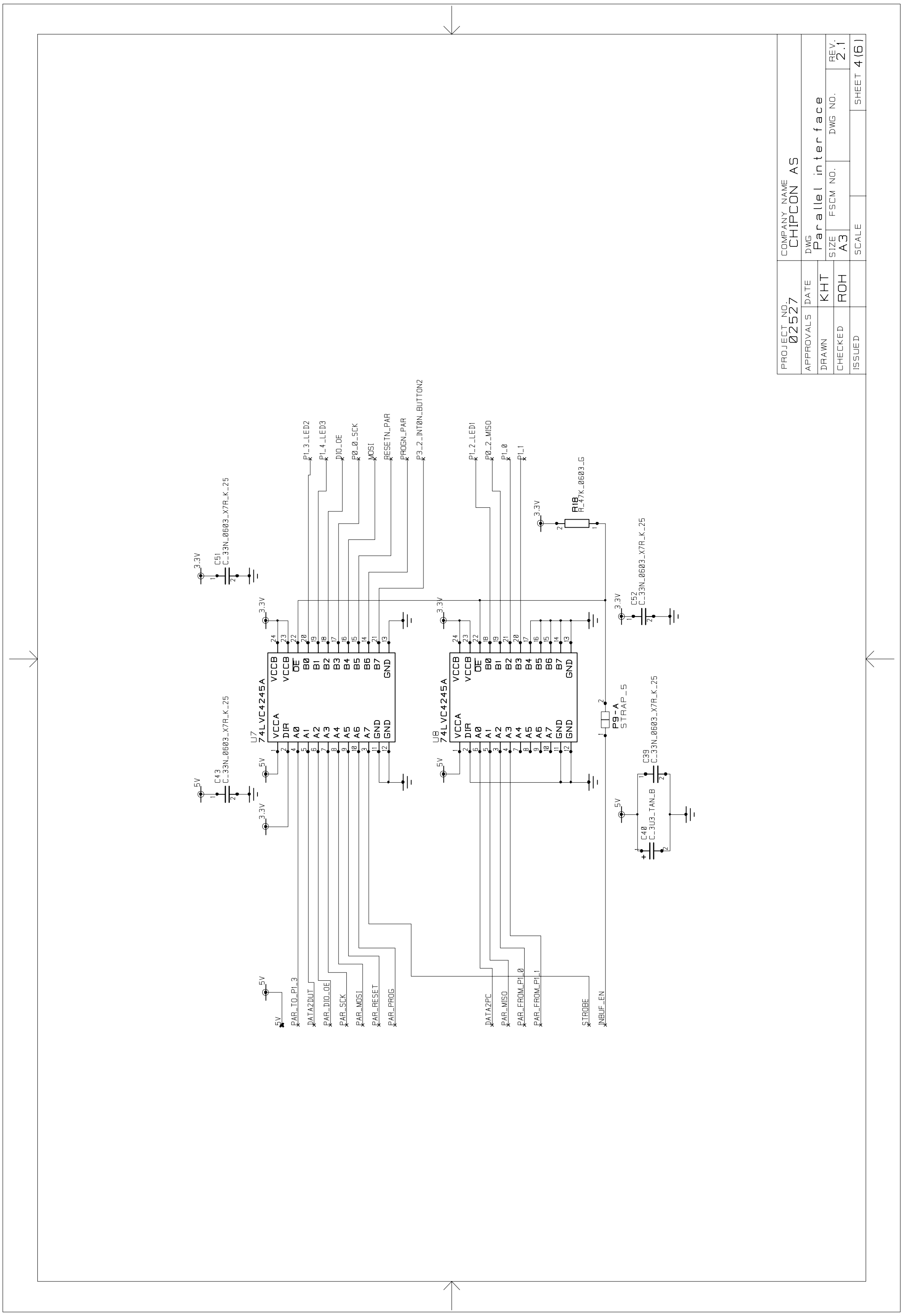
Figure 9: CC1010EB component placement

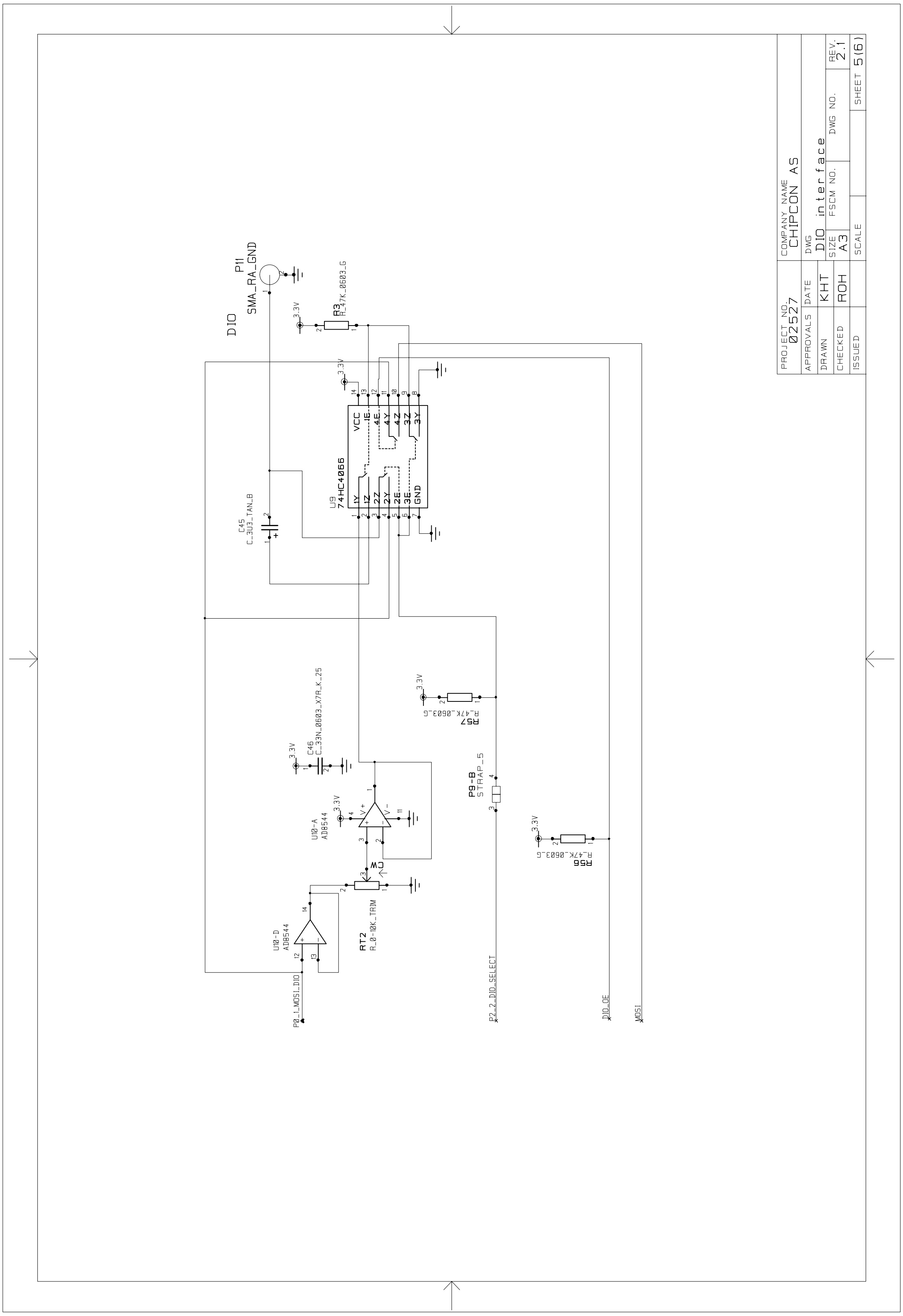
Schematics, CC1010EB

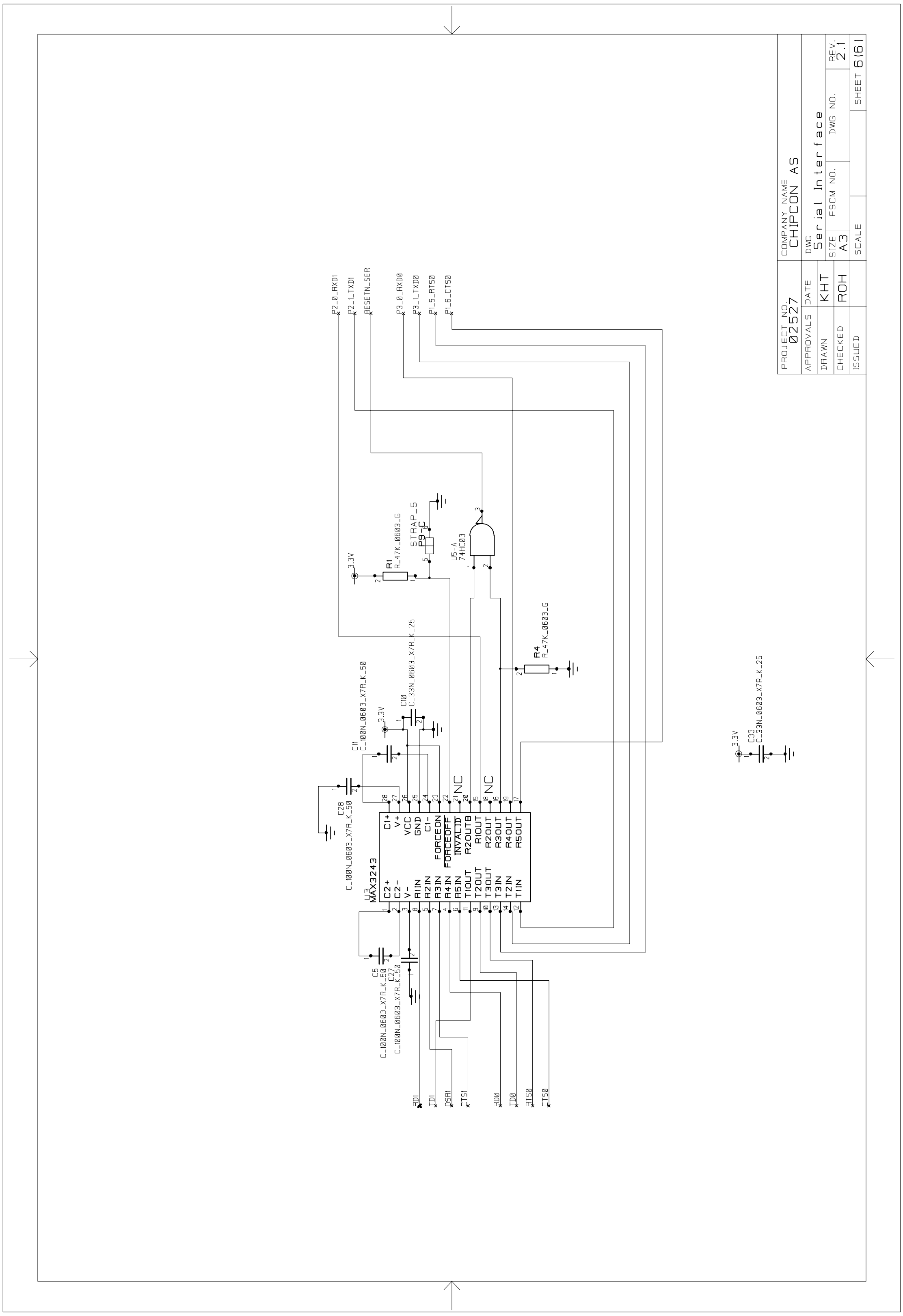



PROJECT NO.
02527
APPROVALS
DATE
DRAWN
KHT
CHECKED
ROH
ISSUED
COMPANY NAME
CHIPCON AS
DWG
Voltage regulator
SIZE
A3
FSCM NO.
DWG NO.
REV.
2.1
SCALE
SHEET 2(6)
3.3V
C2
C_33N_0603_X7R_K_25
C6
C_3U3_TAN_B
C1
C_3U3_TAN_B
U4
LP2981-3.3V
In
Out
VREG
On/Off
Gnd
S1
SWITCH_SPDT
C3
C_3U3_TAN_B
D1
BAT254
A
K
Unreg
GND
Reg


3kHz analog PWM filters
Analog connector
SPI connector
I/O Connector B
I/O Connector A
Reset button
AD1/REF
AD2/RSSI/IF
DCLK
LOCK
N/C
PROJECT NO.
02527
COMPANY NAME
CHIPCON AS
DWG
Digital section
DRAWN
KHT
CHECKED
ROH
SIZE
A3
REV.
2.1
SHEET 3(6)


PROJECT NO.
02527
COMPANY NAME
CHIPCON AS
APPROVALS
DATE
DWG
Parallel interface
DRAWN
KHT
CHECKED
ROH
ISSUED
SIZE
A3
FSCM NO.
DWG NO.
REV.
2.1
SCALE
SHEET 4(6)
U7
74LVC4245A
U8
74LVC4245A


DIO
P11
SMA_RA_GND
R3
R_47K_0603_G
U9
74HC4066
C45
C_3U3_TAN_B
C46
U10-A
AD8544
U10-D
AD8544
RT2
R57
R56
P9-B
STRAP_5
P0_1_MOSI_DIO
P2_2_DIO_SELECT
DIO_OE
MOSI
PROJECT NO.
02527
COMPANY NAME
CHIPCON AS
DWG
DIO interface
APPROVALS
DATE
DRAWN
KHT
CHECKED
ROH
ISSUED
SIZE
A3
FSCM NO.
DWG NO.
REV.
2.1
SCALE
SHEET
5(6)


PROJECT NO.
02527
COMPANY NAME
CHIPCON AS
APPROVALS
DATE
DWG
Serial Interface
DRAWN
KHT
CHECKED
ROH
ISSUED
SIZE
A3
FSCM NO.
DWG NO.
REV.
2.1
SCALE
SHEET 6(6)
MAX3243

Bill of Materials, CC1010EB

Bill of materials, CC1010EB Evaluation Board			
Reference	*Description*	*Value*	*Part*
C1	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C2	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C3	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C5	Capacitor 0603	100nF, 10%	C_100N_0603_X7R_K_50
C6	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C10	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C11	Capacitor 0603	100nF, 10%	C_100N_0603_X7R_K_50
C16	Capacitor 0603		DNM
C27	Capacitor 0603	100nF, 10%	C_100N_0603_X7R_K_50
C28	Capacitor 0603	100nF, 10%	C_100N_0603_X7R_K_50
C29	Capacitor 0603	100pF, 5%	C_100P_0603_NP0_J_50
C33	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C36	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C37	Capacitor 0603	2.2nF, 10%	C_2N2_0603_X7R_K_50
C38	Capacitor 0603	2.2nF, 10%	C_2N2_0603_X7R_K_50
C39	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C40	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C43	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C44	Capacitor 0603	100pF, 5%	C_100P_0603_NP0_J_50
C45	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C46	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C48	Capacitor, tantal	3.3uF	C_3U3_TAN_B
C51	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C52	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
D1	Diode, Si		BAT254
D2	LED, green, SMD		LED_CL150GCD, Citizen
D3	LED, red, SMD		LED_CL150URCD, Citizen
D4	LED, yellow, SMD		LED_CL150YCD, Citizen
D5	LED, blue, SMD		LED_EL15-21UBC, Everlight
H1	Circuit board support		Distance 12.5mm
H2	Circuit board support		Distance 12.5mm
H3	Circuit board support		Distance 12.5mm
H4	Circuit board support		Distance 12.5mm
L5	Inductor, 0805	120nH	L_120N_0805_J

Bill of materials, CC1010EB Evaluation Board			
Reference	*Description*	*Value*	*Part*
L6	Inductor, 0805	120nH	L_120N_0805_J
P1	SMD pin-row header, .050 spacing		TFM-120-02-S-D-K-TR-A, Samtec
P2	SMD pin-row header, .050 spacing		TFM-120-02-S-D-K-TR-A, Samtec
P3	D-Sub, 9-pin		DSUB_9 (male)
P5	Pin-row, 2x5		PINROW_2X5
P7	D-Sub, 9pin		DSUB_9 (male)
P8	Pin-row, 2x5		STRAP_5
P9	Pin-row, 2x5		STRAP_5
P10	SMA connector		SMA (Right angle)
P11	SMA connector		SMA (Right angle)
P12	D-Sub, 25-pin		DSUB_25
P13	SMA connector		SMA (Right angle)
P14	Pin-row, 2x10		PINROW_2X10
P15	Pin-row, 2x5		PINROW_2X5
P16	Pin-row, 2x10		PINROW_2X10
P17	SMA connector		SMA (Right angle)
P20	5-pin terminal, screw		SCREW_TERM_5
P21	DC jack, 2.5mm center pin		DC_JACK_2.5
R1	Resistor 0603	47kΩ	R_47K_0603_G
R2	Resistor 0603	47kΩ	R_47K_0603_G
R3	Resistor 0603	47kΩ	R_47K_0603_G
R4	Resistor 0603	47kΩ	R_47K_0603_G
R11	Resistor 0603	47kΩ	R_47K_0603_G
R12	Resistor 0603	47kΩ	R_47K_0603_G
R13	Resistor 0805	270Ω	R_270_0805_J
R14	Resistor 0805	270Ω	R_270_0805_J
R15	Resistor 0805	270Ω	R_270_0805_J
R16	Resistor 0805	270Ω	R_270_0805_J
R17	Resistor 0603	150kΩ	R_150K_0603_J
R18	Resistor 0603	47kΩ	R_47K_0603_G
R19	Resistor 0603	150kΩ	R_150K_0603_J
R20	Resistor 0805	270Ω	R_270_0805_J
R21	Resistor 0805	270Ω	R_270_0805_J

Bill of materials, CC1010EB Evaluation Board			
Reference	*Description*	*Value*	*Part*
R22	Resistor 0805	270Ω	R_270_0805_J
R23	Resistor 0805	330Ω	R_330_0805_J
R56	Resistor 0603	47kΩ	R_47K_0603_G
R57	Resistor 0603	47kΩ	R_47K_0603_G
RT1	Trimming potmeter, 10K, knob	10kΩ	72PTR10K, BI Technologies
RT2	Trimming potmeter, 10K, knob	10kΩ	72PTR10K, BI Technologies
S1	SPDT switch		SWITCH_SPDT
S2	Push button, SMD		SKHUAF, Alps
S3	Push button, SMD		SKHUAF, Alps
S4	Push button, SMD		SKHUAF, Alps
S5	Push button, SMD		SKHUAF, Alps
S6	Push button, SMD		SKHUAF, Alps
TP6	Test point		TESTPIN
U2	Temperature sensor, SOT23		Do Not Mount
U3	RS-232 Transceiver, 3-5V		MAX3243EEWI, Maxim
U4	3.3V low drop-out regulator		LP2981AIM5-3.3, National Semiconductor
U5	Quad NAND gate w/ open drain output		74HC03
U6	Hex non-inverting buffer, tri-state output		74HC365
U7	Octal dual-supply buffer, tri-state output		74LVC4245A
U8	Octal dual-supply buffer, tri-state output		74LVC4245A
U9	Quad bilateral switch		74HC4066
U10	Quad rail-to-rail opamp		AD8544AR, Analog Devices

Using the Development Kit

The Development Kit is useful for providing hands-on experience with the CC1010 for both software and hardware developers. The plug-in Evaluation Module provides flexibility; it can operate both in a stand-alone fashion and together with the Evaluation Board. Using the Evaluation Board, it is easy to interface the CC1010 with both test equipment and additional application circuitry without having to make a PCB from scratch. Below we will highlight the most useful setups.

CC1010 RF Evaluation using SmartRF® Studio

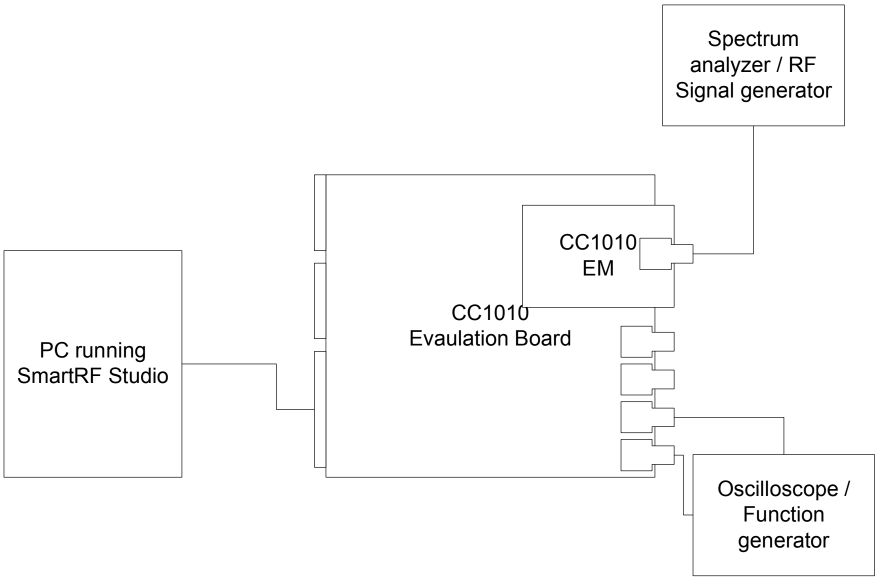


Figure 10: RF Evaluation using SmartRF® Studio

Using the setup shown below, the RF performance of the CC1010 can be evaluated. Use a parallel cable to connect the parallel interface of the CC1010EB to the parallel port of a PC running SmartRF® Studio. You can then use SmartRF® Studio to control all the RF parameters of the CC1010. To test the CC1010 in receive mode, apply an FSK signal from an RF signal generator to the antenna input of the CC1010EM. You can then observe the DIO and DCLK signals using an oscilloscope.

To test the CC1010 in transmit mode, apply a 0-3V square wave on the DIO connector. For best results, this signal should be synchronized with the DCLK signal. The transmitted RF signal can be studied on a spectrum analyzer or sent to a receiver.

Please note that we recommend that the SER OFF jumper be present when precise RF measurements are done in order to prevent noise from the charge pump power supply of the RS-232 level converter from disturbing your measurements.

Important: *The use of radio transceivers is regulated by international and national rules. Before transmitting an RF signal on an antenna, please contact your local telecommunication authorities to make sure that you are licensed to operate the transceiver.*

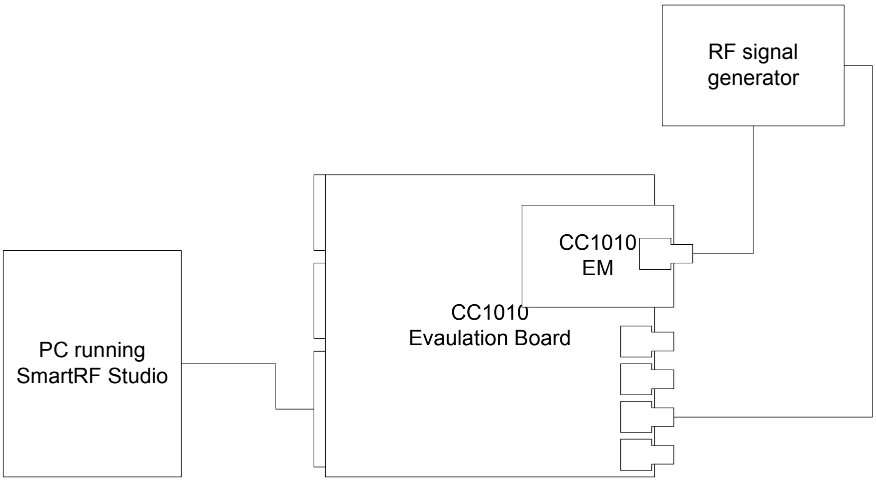


Figure 11: BER testing using SmartRF® Studio

SmartRF® Studio also includes built-in support for BER (bit-error rate) testing. Such test must be performed to determine sensitivity, blocking and other important parameters.

To perform a BER test, the Evaluation Board should be connected with a parallel cable to a PC running SmartRF® Studio, as in the previous setup. The RF output of an RF signal generator should be connected to the antenna connector of the CC1010EM Evaluation module. The DIO connector on the Evaluation Board should be connected to the modulation input of the signal generator. RF signal generators usually require a modulation signal of specific amplitude. The amplitude of the DIO signal can be adjusted by turning the DIO ATT potmeter. Please note that the signal is AC-coupled, and that any signal below –0.7V will be clipped by the output circuitry. Please use an oscilloscope to observe the DIO signal and make sure it is compatible with the requirements of your RF signal generator *before* you apply the signal to expensive lab equipment!

In PCB revisions 3.0 and later, there is a dedicated analog data out connector. This output does not clip signals below –0.7V.

In this first revision, the BER testing does not work reliably with data rates above 4.8kbaud. The result will be continuously displayed by SmartRF® Studio. Make sure that you have put the CC1010 into RX mode.

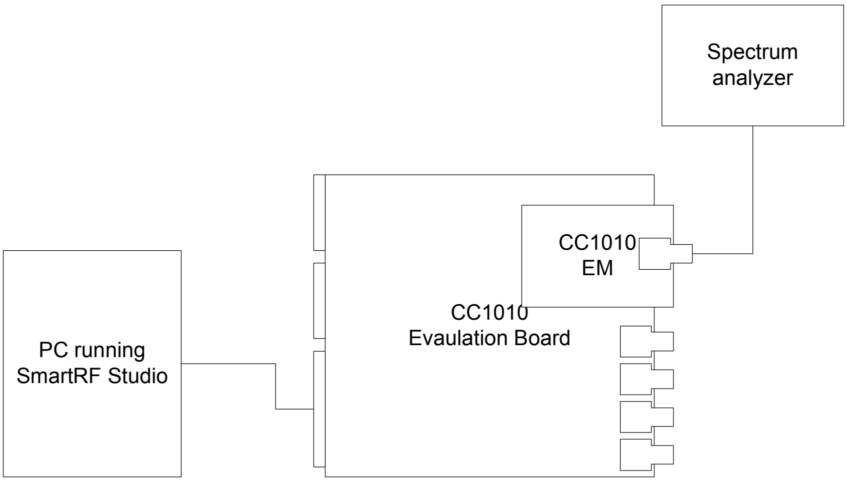


Figure 12: Modulation testing using SmartRF® Studio

The CC1010 RF performance in transmit mode can also be evaluated without using any externally applied modulation, as SmartRF® Studio implements an internal function generator as well.

Just connect the antenna connector of the CC1010EM to a spectrum analyzer, put the CC1010 into TX mode in SmartRF® Studio, and enable the BER estimator. You can choose between square wave and pseudo-random signals.

Important: *The use of radio transceivers is regulated by international and national rules. Before transmitting an RF signal on an antenna, please contact your local telecommunication authorities to make sure that you are licensed to operate the transceiver.*

Software development using the IDE

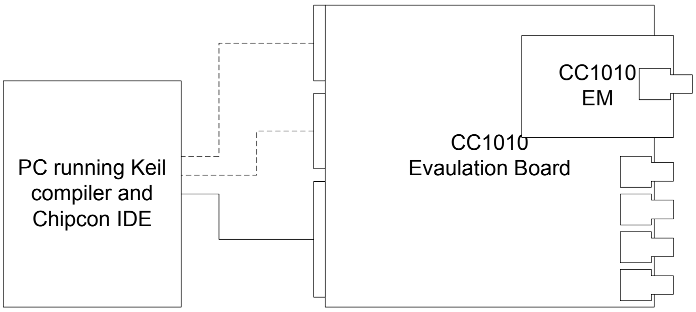


Figure 13: Software development setup

The setup shown in the figure above is suited to all software development. The Evaluation Board should be connected to the PC using a parallel cable, this is used during Flash programming of the chip. If you are using the debugger, a null-modem serial cable should be connected from a serial port on the computer to the SERIAL 1 connector on the Evaluation Board. Once the debug monitor has been downloaded through the parallel port, applications can be downloaded through the serial port simply by starting a debugging session. You can also use a terminal emulation program to communicate with the CC1010 by connecting a null-modem serial cable to the SERIAL 0 connector on the Evaluation Board.

The source code examples have all (except the SPI example requiring an external chip) been designed to run in the configuration shown above. All of the peripherals on the Evaluation Board are available to make quick prototyping easy.

If your application requires additional hardware, this can be connected to the analog and digital I/O pin-row connectors, enabling you to prototype an application without making a custom PCB.

Serial cable pinout

Serial cables to be used with the CC1010EB should be wired as shown in the following figure:

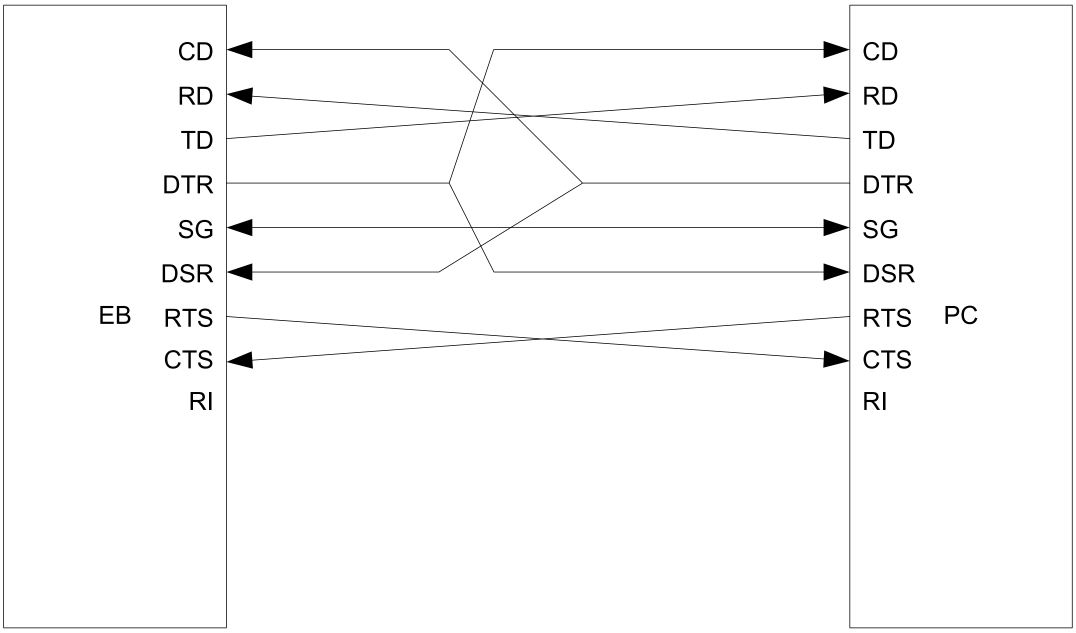


Figure 14: Null-modem cable wiring diagram

A quick verbal summary:

- DTR is connected to CD and DSR.
- RD and TD are crossed.
- SG is connected straight through.
- RTS and CTS are crossed.
- RI is not connected.

Troubleshooting

It doesn't work

- First, measure the voltage between the TP3 and TP4 test points; these are enclosed in bare copper areas on the CC1010EM module. If the voltage here is zero, this indicates that there is something wrong with the power supply.
- Make sure that either a jumper or an amperemeter is connected between the I_IN and I_OUT terminals on the power connector.
- Make sure that the voltage selection switch is set correctly, and that the power supply is connected to the correct pins on the power connector.
- Is the supply voltage correctly polarized? If not, the protection diode will prevent any current from flowing. + and – are indicated on the PCB, on the DC jack, the tip is + and the ring is –.

I cannot program the CC1010

- Make sure that the PAR EN and PAR PROG jumpers are enabled.
- Make sure that you have selected the correct parallel port and crystal frequency in the Flash Programmer program.

I cannot communicate with the CC1010 using the serial port

- Make sure that the SER OFF jumper is removed
- Make sure that you are using a correctly wired null-modem cable

The CC1010 doesn't operate below 3.1V (2.9±0.2V)

- This means that the POR (power-on reset) circuitry of the CC1010 is active. If you wish to turn it off, please remove the POR ON jumper.

The CC1010 consumes more than the rated current in power-down mode

- Please be aware that the current measurement measures all current drawn by the CC1010EM module. The temperature sensor alone draws more than 100uA of current, and a single pull-up resistor draws 70uA of current if the I/O line is forced low. To make accurate measurements of power-down current, de-solder the temperature sensor from the board, and make sure that all CC1010 I/O pins are either configured as inputs, or are set to a high state before entering power-down mode. Also make sure that the CC1010 is shut down in the proper way (see the FAQ at www.chipcon.com for more information about this).

The debugger cannot communicate with the CC1010

- Make sure the SER OFF jumper is removed.
- Make sure that you are using a correctly wired null-modem cable, and that it is plugged into serial port 1.
- Make sure that the debug monitor is programmed into the CC1010
- Make sure that the debug settings in the Keil compiler are set correctly. Refer to the IDE User Manual and the Keil documentation for more information.

I'm having problems with the CC1010EM locking up when I operate it without having it plugged into the CC1010EB.

- On PCB revisions 2.0 and older, the TEST_N pin of the CC1010 is left floating, only connected to a capacitor. If this capacitor is drained, the CC1010 may enter test mode. When the CC1010EM is plugged into the CC1010EB evaluation board, there is no problem, as this board includes a strap to connect the TEST_N signal to VDD.
- Chipcon recommends that you connect the TEST_N pin to VDD if you intend to operate the CC1010EM without having it plugged into the CC1010EB. This is most easily done by soldering a short piece of wire between the R28 pad closest the CC1010 and C47 pad closest to R28.

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